

Supplementary Information

Exchange-coupled SmCo₅/Co nanocomposites synthesized by a novel strategy

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Experimental Section

Synthesis of SmCo₅/Co: SmCo₅ nanoparticles were synthesized by reductive annealing of SmCo-OH at 870 °C, based on our previous strategy. 200 mg synthesized SmCo₅ nanoparticles first were heated quickly to 400 °C under vacuum in furnace tube. Then H₂ was allowed to quickly fill into the furnace tube. A hydrogen pressure of 4 MPa was kept for different time to control the proportion of precipitated Co. After the reaction end, the furnace tube was removed from heating source to achieve quick cool. When the temperature reduced to room temperature, the powders were further washed to dissolve the extra SmH₂. Firstly, the powders were dispersed into 200 ml deionized water by ultrasonic concussion for 30 min to fully run the reaction: $2\text{SmH}_{2\pm x} + 6\text{H}_2\text{O} = 2\text{Sm}(\text{OH})_3 + (5\pm x)\text{H}_2$. Then, 5% acetic acid aqueous solution was dropped into this solution under vigorous mechanical stirring to wash Sm(OH)₃ when pH Meter was adopted to measure the pH of the solution. After the pH reaching 7, the dropping was stopped and the centrifugal separation was operated at 8000 rpm for 5 min. The black nanoparticles were collected for further characterization.

Characterization: The crystallographic structure was identified by X-ray diffraction (XRD, D/MAX 2500 PC) with Cu-K_α radiation ($\lambda=0.15418$ nm) and scanning speed of 5°/min. The ratio of elements in SmCo₅ with 30 min hydrogenation at different steps is further measured by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES). The microstructure and morphology of the particles were investigated using transmission electron microscopy (TEM, JEM-2100). For TEM observations, the samples were dispersed in hexane with 1–2 drops of

ethanol in it. The drops of the well dispersed nanoparticles were placed over the carbon coated microscopic copper grids (200 mesh size) and were subsequently dried. The magnetic properties were measured at room temperature using a Physical Property Measurement System (PPMS) under a maximum applied field of 90 kOe.

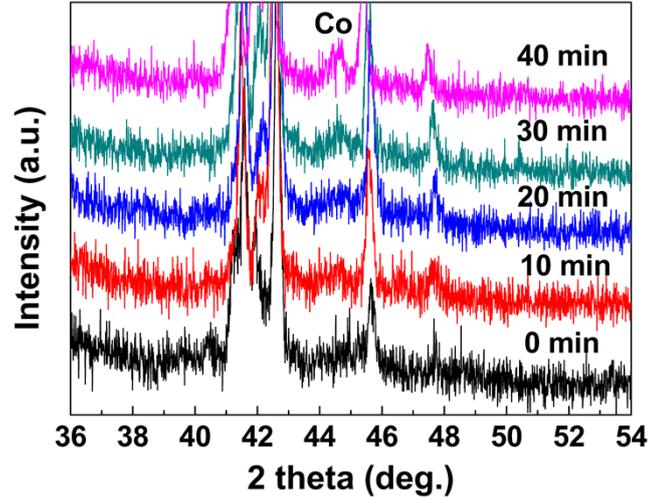


Figure S1 magnification of diffraction patterns of Co with different hydrogenation time

Reference Intensity Ratio (RIR) method: For different materials, these have some RIR value, also named K. The K is standardized using the Al_2O_3 . In the mixture of material A and Al_2O_3 with mass ratio of 1:1, the K of material A is that the maximum integrated intensity of mixture divide by maximum integrated intensity of Al_2O_3 (

$K_{\text{Al}_2\text{O}_3}^{\text{A}} = \frac{K^{\text{A}}}{K_{\text{Al}_2\text{O}_3}^{\text{A}}} = \frac{I^{\text{A}}}{I_{\text{Al}_2\text{O}_3}^{\text{A}}}$). For a sample containing of phase A, B, C and so on, the

K can be expressed as:

$$K_{\text{Al}_2\text{O}_3}^{\text{A}} = \frac{K_{\text{Al}_2\text{O}_3}^{\text{A}}}{K_{\text{Al}_2\text{O}_3}^{\text{A}}} = 1, K_{\text{Al}_2\text{O}_3}^{\text{B}} = \frac{K_{\text{Al}_2\text{O}_3}^{\text{B}}}{K_{\text{Al}_2\text{O}_3}^{\text{A}}}, K_{\text{Al}_2\text{O}_3}^{\text{C}} = \frac{K_{\text{Al}_2\text{O}_3}^{\text{C}}}{K_{\text{Al}_2\text{O}_3}^{\text{A}}} \text{ and so on.}$$

For some system containing of N phases, the mass fraction of phase X (W_{X}) can be expressed as:

$$W_{\text{X}} = \frac{I_{\text{X}_i}}{K_{\text{Al}_2\text{O}_3}^{\text{X}} \sum_{i=\text{A}}^{\text{N}} \frac{I_i}{K_{\text{Al}_2\text{O}_3}^{\text{i}}}}.$$

If there are only two phases in a system,

$$W_A = \frac{I_A}{I_A + \frac{I_B}{K_A}}, W_B = \frac{I_B}{I_B + I_A K_A} = 1 - W_A.$$

Here W_A is weight percent of A phase, $K_A^B = K_B/K_A$, I_A and I_B are maximum integrated intensity (I_{area}) of all peaks in A phase and B phase respectively. According to the data in JADE, $K_{SmCo_5} = 7.29$, $K_{Co} = 6.35$.